Upper Limb Nerve Conduction Study: A Normative Reference Study Among Young Healthy Individuals

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Abstract: Background: *Background:* In this study we have tried to derive normative reference values for commonly tested motor and sensory nerve conduction studies of right and left side of upper limb nerves in 86 healthy individuals of Bhavnagar city of Gujarat, India. Material And Method*:* the study was done on total of 86 apparently young healthy males and females aged between 18 to 36 years. Nerve conduction studies of Median nerve, Ulnar nerve and Radial nerve for both sides of limbs were done. All the data were recorded and statistically analysed. Result: From this study we have derived Normative reference values for upper limb nerves. Derived nerve conduction velocity values are:Median nerve MNCV63.09 ± 1.89 m/s;SNCV 55.38 ± 6.98 m/s,Ulnar nerve MNCV 58.30 ± 8.46 m/s; SNCV 53.44 ± 3.98 m/s, Radial nerve MNCV 57.29 ± 13.31m/s;SNCV 66.19 ± 8.78 m/s, Conclusion*:* The present study derived normative reference data for the motor and sensory components ofnerve conduction Study of nerves of the upper limbs like the Median nerve, Ulnar nerve, and radial nerve in the population of Bhavnagar district.

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Introduction: Nerve conduction studies have become a simple and reliable test of peripheral nerve function; with the help of motor nerve conduction and sensory nerve conduction studies, we can diagnose various kinds of focal and diffuse neuropathies. For an accurate diagnosis, the quality of the normative Database plays an important role. Normative data is a set of values derived from disease– free individuals[1]. Most neurophysiological evaluation in the clinical setting makes a comparison between a patient finding and some normative data. We have very limited normative data for nerve conduction studies of demographic area wise Indian population, because of the lack of local normative data, Indian neurodiagnostic laboratories are using standard values generated in the USA and Europe, to make a diagnosis of different neuroconduction abnormalities.

There cannot be a universal reference value of a particular nerve, so it is recommended that the reference values should be taken in each institute's laboratories from a sample with anthropometric characteristics similar to the local population. From this study we can derive normal values for nerve conduction of tibial, common peroneal, superficial peroneal, and sural nerves, which will be helpful in the proper working of neuro-diagnostic labs of Bhavnagar city to compare and diagnose neuropathies accurately

Material & Methods: The study was done after taking permission from Ethics Committee, government Medical College, Bhavnagar. [EC approval no. (1046/2021)]it was a cross sectional study conducted on 86 young, apparently healthy, adults of Bhavnagar district. Apparently normal, healthy adult individuals of 18-65 years of age were included. Subjects with diabetes, with habits of alcohol consumption and smoking, past history of lower limb injury, and history of surgical intervention of lower limb were excluded. All subjects were included in the study after taking their written informed consent. Study was carried out at NCV-EMG lab.

Participant's personal information like name, age, gender was recorded. Height and weight were measured according to standard WHO protocol using, stadiometer and weighing machine. And BMI was calculated from that. Blood pressure was measured using sphygmomanometer according to standard WHO protocol to exclude newly diagnosed hypertensive patients. Participants were asked before time, not to apply any cream or oil on body, to prevent extra skin resistance to applied current stimulation. Skin

surface was cleaned with spirit swab, and air dried before placing electrodes.

Motor and sensory conduction of lower limb nerves were performed with standard protocol guidelines. At least two different sites of a nerve were stimulated and results were recorded. Conduction velocity and F wave of Tibial, Common Peroneal, Superficial peroneal and Sural nerves for both right and left side were recorded.

NCV recording procedures: Ingeneral settings of procedure, room temperature was maintained at 25-28℃. The filters were set at 10-2kHz, sweep speed at 2ms/division and stimulation strength at 0-100 mA for an effective nerve stimulation. Supramaximal stimulation was given for and adequate response.

1 cm disc electrodes were used for motor and sensory nerve conduction studies. Following parameters were measured like DL distal latency, distal Amplitude, PL proximal latency, proximal Amplitude. Distance between two stimulating sites was measured from cathode to cathode for motor nerve conduction and for sensory conduction velocity, distance between recording and stimulating sites was recorded, by measuring tape. Motor nerve conduction velocity (MNCV) and Sensory nerve conduction velocity (SNCV) were measured. standardize methods were used to record motor and sensory studies. method for Tibial motor nerve conduction velocity recording[2,3]: Active electrode was placed over the medial foot, slightly anterior and inferior to the tubercle of the navicular bone at the most superior point of the arch formed by the junction of planter skin and dorsal foot skin, on abductor hallucis muscle.

Reference electrode was placed Slightly distal to the 1st metacarpophalangeal joint on the medial surface of the joint. Ground electrode placed on dorsum of foot. Stimulation points: S1: behind and proximal to the medial malleolus. Cathode placed 8 cm proximal to the active electrode measured in straight line with the ankle in central position and slightly posterior to the medial malleolus. anode is proximal.S2: cathode is placed at the mid popliteal fossa or slightly medial or lateral to the midline. anode is proximal. For Common Peronealmotor nerve conduction velocity recording[2,3]: Active electrodeplaced on the dorsal lateral foot over the belly of extensor digitorum brevis. Reference electrode on distally over the meta tarso phalangeal joint of little toe, and Ground electrode placed between the recording and stimulating electrodes over the anterior leg.Stimulation points were, S1: Anterior ankle slightly lateral to tibialis anterior tendon, and S2below the fibular head

for Superficial Peronealsensory nerve conduction velocity recording[2,3]: Active electrode placed just above the junction of lateral one third of a line connecting two malleoli, Reference electrode at 3 cm distal to the active electrode. Both active and reference electrode will be placed in the midline of ankle joint anteriorly on dorsal aspect, and ground electrode was placed on Anterior surface of leg. Stimulating site was antidromic surface stimulation is carried out 10-15 cm proximal to the upper edge of lateral malleolus, anterior to the peroneus longus muscle.

For Suralsensory nerve conduction velocity recording[2,3]: Active electrode is placed above or immediately below and behind the lateral malleolus, between lateral malleolus and tendo Achilles. Reference electrode on 2-3 cm distal from active electrode along the lateral dorsum of the foot and ground electrode: on the posterior aspect of leg between recording electrodes and stimulating electrode. Stimulating sitewas10-16 cm proximal to the recording electrode, distal to the lower border of gastrocnemius muscle - at the junction of middle and lower one third of leg. Leg should be relaxed and in lateral position.

All recorded data were entered in Microsoft Excel Sheet. for data analysis GraphPad InStat 3 software was used. Data are expressed in mean ± SD. Statistically significant result indicated by 'p' value <0.05.

Result: This study was done in 86 healthy, young volunteer participants. Among which total male participants were 45 and total females were 41. mean age, height, weight, and BMI for male and female participants are as per Table 1

Table 1: Demographic Data

	Male (n=45)	Female (n=41)
Age	23.65 years	22.78 years
Height	1.68 meters	1.57 meters
Weight	65.67 kg	51.49 kg
BMI	23.29kg/m^2	20.85kg/m^2

Motor nerve conduction parameters for Tibial and Common Peroneal nerve for right and left side of the limbs as shown below:

Table 2 Tibial nerve and Common Peroneal nerve parameters

NCS parameters	Right side (n=86)	Left side (n=86)	P value
Tibial nerve ankle latency (msec)	3.11±0.55	3.10±0.56	0.88
Tibial nerve ankle amplitude(mv)	6.09±1.05	6.28±0.97	0.47
Tibial nerve knee latency(msec)	10.89±1.22	11.05±1.12	0.48
Tibial nerve knee amplitude(mv)	6.75±1.04	7.11±1.12	0.0296*
Tibial nerve MNCV (m/sec)	46.64±4.45	45.65±4.69	0.16
Common peroneal ankle latency (msec)	3.38±0.41	3.44±0.44	0.34
Common peroneal ankle amplitude(mv)	6.18±0.64	6.32±0.72	0.17
Common peroneal knee latency(msec)	10.98±1.08	11.28±1.11	0.07
Common peroneal knee amplitude(mv)	6.59±1.06	6.18±0.63	0.0021*
Common peroneal nerve MNCV (m/sec	47.61±3.98	46.28±4.90	0.05

*Value shows significant result.

Sensory nerve conduction parameters for Superficial Peroneal and Sural nerve for right and left side of the limbs as shown below:

Table 3 superficial Peroneal nerve and Sural nerve parameters

NCS parameters	Right side (n=86)	Left side (n=86)	P value
Superficial peroneal lateral malleolus latency (msec)	2.93±0.45	2.92±0.35	0.87
Superficial peroneal lateral malleolus amplitude(μv)	15.51±3.08	14.67±2.15	0.0389*
Superficial peroneal SNCV (m/sec)	51.87±5.91	51.91±7.36	0.97
Sural midcalf latency (msec)	2.77±0.13	2.76±0.13	0.69
Sural midcalf amplitude(μv)	16.58±2.34	17.13±2.25	0.12
Sural nerve SNCV(m/sec)	59.68±2.42	59.74±2.66	0.87

F wave parameters for Tibial and Peroneal nerve are shown in Table 4

Table 4 : F wave parameters for Tibial and Peroneal nerve

F wave parameters	Right side (n=86)	Left side (n=86)	P value
F wave min. latency Tibial nerve (msec)	46.62±2.50	46.03±5.59	0.37
F wave mean latency Tibial nerve (msec)	50.61±1.38	49.91±5.57	0.26
F wave min latency peroneal nerve(msec)	45.29±1.30	45.22±1.29	0.72
F wave mean latency peroneal nerve (msec)	49.82±0.65	49.77±0.69	0.61

Discussion: In this study an attempt was made to derive normative data for nerve conduction velocity of commonly tested motor and sensory nerves of lower limbs. Total 86, young, healthy adults of Bhavnagar district were included. As per tables shown in result part, latency, amplitude F wave minimum and mean latency and nerve conduction velocity for Tibial, Common Peroneal, Superficial peroneal and Sural nerves were derivedwith comparison of right and Left side values. Overall, our normal values show somewhat similar findings with the results derived in the Saudi population by the study Mohammed H. Alanazy et al[4], the Pakistani study by zaitoon Shivii et al[5], and the Korean population study by Jae Yoon Kim et al[6] data. Variation between right and left side of NCV values[7,8]

We have recorded nerve conduction parameters on both the right and left sides of limbs and compared values with each other to see if there is any difference present. As per our results, all values are comparable except, for Tibial nerve knee amplitude, common peroneal nerve knee amplitude, and superficial peroneal amplitude, they show statically significant differences in values.

As per Buschbacher's results, up to 50% to 60% side-to-side difference in amplitude and 15% to 20% difference in NCV for the Tibial and the common peroneal nerve is tolerable. Our results show Tibial nerve knee amplitude on the right side 6.75±1.04 and left side 7.11±1.12, common peroneal knee amplitude on the right side 6.59±1.06 and left side 6.18±0.63, and for superficial peroneal nerve amplitude on right side 15.51±3.08 and left side 14.67±2.15, thus, differences are tolerable.

F wave latency[9.10] : As per Table 4, we have derived F min. Latency for Tibial (46.62±2.50) and for peroneal (45.29±1.30) and F mean latency for Tibial (50.61±1.38) and Peroneal nerve (49.82±0.65), values are within normal range and comparable with the study of Morris A. Fisher[9]. There is no statistically significant difference between right and left sides.

Limitations of our study : The main limitation of our study was the age of recruited participants and the small study population, as this study was done during the COVID pandemic time.

Conclusion: The present study derived normative reference data for the Nerve conduction Study of commonly performed nerves of the lower limbs like the Tibial nerve, Common Peroneal nerve, Superficial peroneal nerve, and Sural nerve in the population of Bhavnagar district.

Obtained data of various nerve conduction parameters for our population is somewhat comparable with Saudi and Asian population studies done. On doing a comparison between the right and left sides of the limbs, nerve parameters turned out to be comparable.

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